

WHAT IS CLAIMED IS:

1. An image processing apparatus which multiplexes noise on multilevel image data to embed visible additional information with a noise-multiplexed
5 distribution, comprising:
 - input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel;
 - determination means for determining on the basis
10 of the additional information whether a pixel of interest in the multilevel image data is located at a position where noise is to be multiplexed;
 - specifying means for, when said determination means determines that the pixel of interest is located
15 at the position where noise is to be multiplexed, specifying a second bit region where noise is to be multiplexed, on the basis of a state of a first bit region in a bit configuration which constitutes the pixel of interest; and
 - 20 change means for reversibly changing bit information for the second bit region of the pixel of interest specified by said specifying means.
2. The apparatus according to claim 1, wherein, in a case where the multilevel image data includes
25 multilevel image data using a luminance value as a reference, the first bit region includes a predetermined number of upper bits including a most

significant bit, and the second bit region includes lower m bits which include a least significant bit and change in accordance with a value of the second bit region.

- 5 3. The apparatus according to claim 1, further comprises means for setting information on an intensity for multiplexing noise, and

 said specifying means specifies the second bit region on the basis of the set intensity information
10 and the state of the first bit region.

4. An image processing apparatus which removes visible additional information from multilevel image data in which noise is reversibly embedded to multiplex the visible additional information, comprising:

- 15 input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel;

 determination means for determining on the basis of the additional information whether a pixel of
20 interest in the multilevel image data is located at a position where noise is multiplexed;

 specifying means for, when said determination means determines that the pixel of interest is located at the position where noise is multiplexed, specifying
25 a second bit region where noise is multiplexed on the basis of a state of a first bit region in a bit configuration which constitutes the pixel of interest;

and

reconstruction means for performing conversion
inverse to noise multiplexing to reconstruct a state of
the second bit region of the pixel of interest

5 specified by said specifying means into a state before
multiplexing.

5. An image processing apparatus which converts
multilevel image data into frequency component data for
each pixel block of a predetermined size to
10 compression-code the multilevel image data, and
multiplexes noise on the multilevel image to embed
visible additional information with a noise-multiplexed
distribution, comprising:

input means for inputting, as the additional
15 information, information representing whether or not to
multiplex noise for each pixel block of the
predetermined size;

determination means for determining on the basis
of the input additional information whether a pixel
20 block of interest is located at a position where noise
is to be multiplexed;

specifying means for, when said determination
means determines that the pixel block of interest is
located at the position where noise is to be
25 multiplexed, specifying a second bit region where noise
is to be multiplexed, on the basis of a state of a
first bit region in data which constitutes a low

frequency component after conversion of the pixel block of interest; and

change means for reversibly changing bit information for the second bit region in the data of the low frequency component specified by said specifying means.

6. The apparatus according to claim 5, wherein the conversion into the frequency component includes orthogonal transform, and the low frequency component includes a DC component after orthogonal transform.

7. The apparatus according to claim 5, wherein the conversion into the frequency component includes wavelet transform, and the low frequency component includes data of a block of a low frequency component that is generated by wavelet transform a plurality of number of times.

8. The apparatus according to claim 5, wherein, in a case where the multilevel image data includes multilevel image data using a luminance value as a reference, the first bit region includes a predetermined number of upper bits including a most significant bit, and the second bit region includes lower m bits which include a least significant bit and change in accordance with a value of the second bit region.

9. The apparatus according to claim 5, wherein the image processing apparatus further comprises

means for setting information on an intensity for
multiplexing noise, and

said specifying means specifies the second bit
region on the basis of the set intensity information
5 and the state of the first bit region.

10. An image processing apparatus which removes
visible additional information from multilevel image
data that is compression-coded by reversibly embedding
noise, multiplexing the visible additional information,
10 and converting the data into frequency component data
for each pixel block of a predetermined size,
comprising:

input means for inputting, as the additional
information, information representing whether or not to
15 multiplex noise for each pixel block of the
predetermined size;

determination means for determining on the basis
of the input additional information whether a pixel
block of interest is located at a position where noise
20 is multiplexed;

specifying means for, when said determination
means determines that the pixel block of interest is
located at the position where noise is multiplexed,
specifying a noise-multiplexed second bit region on the
25 basis of a state of a first bit region in data which
constitutes a low frequency component after frequency
conversion of the pixel block of interest; and

reconstruction means for performing conversion
inverse to noise multiplexing to reconstruct a state of
the second bit region of the pixel block of interest
specified by said specifying means into a state before
5 multiplexing.

11. An image processing method of multiplexing noise
on multilevel image data to embed visible additional
information with a noise-multiplexed distribution,
comprising:

10 an input step of inputting, as the additional
information, information representing whether or not to
multiplex noise for each pixel;

a determination step of determining on the basis
of the additional information whether a pixel of
15 interest in the multilevel image data is located at a
position where noise is to be multiplexed;

a specifying step of, when the pixel of interest
is determined in the determination step to be located
at the position where noise is to be multiplexed,
20 specifying a second bit region where noise is to be
multiplexed, on the basis of a state of a first bit
region in a bit configuration which constitutes the
pixel of interest; and

a change step of reversibly changing bit
25 information for the second bit region of the pixel of
interest specified in the specifying step.

12. An image processing method of removing visible

additional information from multilevel image data in which noise is reversibly embedded to multiplex the visible additional information, comprising:

an input step of inputting, as the additional
5 information, information representing whether or not to multiplex noise for each pixel;

a determination step of determining on the basis of the additional information whether a pixel of interest in the multilevel image data is located at a
10 position where noise is multiplexed;

a specifying step of, when the pixel of interest is determined in the determination step to be located at the position where noise is multiplexed, specifying a second bit region where noise is multiplexed on the
15 basis of a state of a first bit region in a bit configuration which constitutes the pixel of interest; and

a reconstruction step of performing conversion inverse to noise multiplexing to reconstruct a state of
20 the second bit region of the pixel of interest specified in the specifying step into a state before multiplexing.

13. An image processing method of converting multilevel image data into frequency component data for
25 each pixel block of a predetermined size to compression-code the multilevel image data, and multiplexing noise on the multilevel image to embed

visible additional information with a noise-multiplexed distribution, comprising:

an input step of inputting, as the additional information, information representing whether or not to
5 multiplex noise for each pixel block of the predetermined size;

a determination step of determining on the basis of the input additional information whether a pixel block of interest is located at a position where noise
10 is to be multiplexed;

a specifying step of, when the pixel block of interest is determined in the determination step to be located at the position where noise is to be multiplexed, specifying a second bit region where noise
15 is to be multiplexed, on the basis of a state of a first bit region in data which constitutes a low frequency component after conversion of the pixel block of interest; and

a change step of reversibly changing bit
20 information for the second bit region in the data of the low frequency component specified in the specifying step.

14. An image processing method of removing visible additional information from multilevel image data that
25 is compression-coded by reversibly embedding noise, multiplexing the visible additional information, and converting the data into frequency component data for

each pixel block of a predetermined size, comprising:
an input step of inputting, as the additional
information, information representing whether or not to
multiplex noise for each pixel block of the

5 predetermined size;

a determination step of determining on the basis
of the input additional information whether a pixel
block of interest is located at a position where noise
is multiplexed;

10 a specifying step of, when the pixel block of
interest is determined in the determination step to be
located at the position where noise is multiplexed,
specifying a noise-multiplexed second bit region on the
basis of a state of a first bit region in data which
15 constitutes a low frequency component after frequency
conversion of the pixel block of interest; and

a reconstruction step of performing conversion
inverse to noise multiplexing to reconstruct a state of
the second bit region of the pixel block of interest
20 specified in the specifying step into a state before
multiplexing.

15. A computer program functioning as an image
processing apparatus which multiplexes noise on
multilevel image data to embed visible additional
25 information with a noise-multiplexed distribution,
functioning as:

input means for inputting, as the additional

information, information representing whether or not to multiplex noise for each pixel;

determination means for determining on the basis of the additional information whether a pixel of
5 interest in the multilevel image data is located at a position where noise is to be multiplexed;

specifying means for, when said determination means determines that the pixel of interest is located at the position where noise is to be multiplexed,
10 specifying a second bit region where noise is to be multiplexed, on the basis of a state of a first bit region in a bit configuration which constitutes the pixel of interest; and

change means for reversibly changing bit
15 information for the second bit region of the pixel of interest specified by said specifying means.

16. A computer-readable storage medium storing a computer program defined in claim 15.

17. A computer program functioning as an image
20 processing apparatus which removes visible additional information from multilevel image data in which noise is reversibly embedded to multiplex the visible additional information, functioning as:

input means for inputting, as the additional
25 information, information representing whether or not to multiplex noise for each pixel;

determination means for determining on the basis

of the additional information whether a pixel of interest in the multilevel image data is located at a position where noise is multiplexed;

specifying means for, when said determination
5 means determines that the pixel of interest is located at the position where noise is multiplexed, specifying a second bit region where noise is multiplexed on the basis of a state of a first bit region in a bit configuration which constitutes the pixel of interest;
10 and

reconstruction means for performing conversion inverse to noise multiplexing to reconstruct a state of the second bit region of the pixel of interest specified by said specifying means into a state before
15 multiplexing.

18. A computer-readable storage medium storing a computer program defined in claim 17.

19. A computer program functioning as an image processing apparatus which converts multilevel image
20 data into frequency component data for each pixel block of a predetermined size to compression-code the multilevel image data, and multiplexes noise on the multilevel image to embed visible additional information with a noise-multiplexed distribution,
25 functioning as:

input means for inputting, as the additional information, information representing whether or not to

multiplex noise for each pixel block of the predetermined size;

determination means for determining on the basis of the input additional information whether a pixel
5 block of interest is located at a position where noise is to be multiplexed;

specifying means for, when said determination means determines that the pixel block of interest is located at the position where noise is to be
10 multiplexed, specifying a second bit region where noise is to be multiplexed, on the basis of a state of a first bit region in data which constitutes a low frequency component after conversion of the pixel block of interest; and

15 change means for reversibly changing bit information for the second bit region in the data of the low frequency component specified by said specifying means.

20. A computer-readable storage medium storing a
20 computer program defined in claim 19.

21. A computer program functioning as an image processing apparatus which removes visible additional information from multilevel image data that is compression-coded by reversibly embedding noise,
25 multiplexing the visible additional information, and converting the data into frequency component data for each pixel block of a predetermined size, functioning

as:

input means for inputting, as the additional information, information representing whether or not to multiplex noise for each pixel block of the

5 predetermined size;

determination means for determining on the basis of the input additional information whether a pixel block of interest is located at a position where noise is multiplexed;

10 specifying means for, when said determination means determines that the pixel block of interest is located at the position where noise is multiplexed, specifying a noise-multiplexed second bit region on the basis of a state of a first bit region in data which
15 constitutes a low frequency component after frequency conversion of the pixel block of interest; and

reconstruction means for performing conversion inverse to noise multiplexing to reconstruct a state of the second bit region of the pixel block of interest
20 specified by said specifying means into a state before multiplexing.

22. A computer-readable storage medium storing a computer program defined in claim 21.